

PROCEEDINGS
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SOME NOTES ON FISH SCALES.

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Last summer, thanks to the Bureau of Fisheries, I was enabled to continue my work on fish scales at Woods Hole, where I obtained much interesting material not previously available. Thanks to Dr. F. B. Sumner, Dr. Hugh M. Smith, Dr. B. W. Evermann and others, I have before me a remarkable collection of fish scales, which will form the subject of a report later on. In the meanwhile, the following notes are offered. They were written and sent for publication before I knew how much material I was to obtain, or that means would be found for the publication of a detailed illustrated report.

PLEURONECTIDÆ AND SOLEIDÆ.

The following table will serve for the separation of the scales of a series of flat-fishes, all in the collection of the Bureau of Fisheries Station at Woods Hole, except *Platophrys constellatus*, which is from the collection of the Bureau in Washington.

A. Scales ctenoid on both sides (Soleidæ).

Apical teeth large and few (6 or 7 on upper, 3 to 5 on lower side),
with a well-marked zone of large reticulations at their base .

Achirus lineatus (L.).

No such zone of reticulations at the base of the teeth 1.

1. Scales narrow, with 8 to 20 basal radii *Solea solea* (L.).

Scales larger and broader, with over 30 basal radii

Symphurus piger (Goode and Bean).

Gulf Stream.

Of these, the *Achirus* must be considered the most modified. The three genera represent the subfamilies Achirinæ, Soleinæ and Cynoglossinæ.

B. Scales ctenoid above, cycloid on the lower (blind) side
(Pleuronectidæ).

- Scales large, minutely ctenoid above 1.
 Scales minute 2.
1. Lateral areas with very fine radiating striæ . *Syacium papillosum* (L.).
 Albatross Sta. 2405.
 Lateral areas without such striæ . . . *Citharichthys arcifrons* Goode.
2. Basal radii so many and close as to produce the effect of a fine
 striation; scales broad 3.
 Basal radii not thus numerous 4.
3. Apical teeth of scales on upper side of fish projecting beyond
 margin *Platophrys constellatus* Jordan.
 Magdalena Bay (Albatross).
 Apical teeth of scales on upper side submarginal; so that the
 scales seem cycloid *Platophrys ocellatus* Agassiz.
 Albatross Sta. 2414.
4. Basal radii many, about 15-20 on lower, over 20 on upper side;
 teeth of ctenoid scales few (about 5 to 7) and very sharp . . .
Pseudopleuronectes americanus Walb.
 Basal radii fewer 5.
5. Lateral areas, free from radii, extensive, their circuli dense . . .
Notosema dilectum Goode and Bean.
 Lateral areas, free from radii, small 6.
6. Scales smaller, radii more parallel *Limanda ferruginea* Storer.
 Scales larger, radii less parallel
Hippoglossoides platessoides Fabricius.
- The last two are nearly alike.

C. Scale cycloid on both sides (Pleuronectidæ).

- Scales very small, long-oval, basal radii few
Glyptocephalus cynoglossus L.
 Albatross Sta. 2546.
- Scales much broader, basal radii many 1.
1. Scales smaller; those of lower side about half size of those on
 upper *Lophopsetta maculata* Mitch.
 Scales larger; those of lower side not so much smaller than those
 of upper *Paralichthys oblongus* Mitch.

The *Glyptocephalus* scale is the most modified (degenerate) of the whole series. Some Achirine (not seen by me) are scaleless. With regard to the subfamilies of Pleuronectidæ, it will be noted that each subfamily has produced a genus with cycloid scales on both sides.

It is obvious that the flat-fishes are descended from fishes with the typical Acanthopterygian (ctenoid) type of scales, and that the cycloid scales have arisen through loss of the ctenoid character. From all we know about inheritance, it appears practically certain that this character, once completely lost on the lower side, would not return in the well-developed condition in which it occurs in the soles. It must, therefore, be held that the Soleidæ are not derived from the ordinary Pleuronectidæ, but rather from some ancient type of flat-fish, probably now without living representatives. There is, however, a living genus of Pleuronectids

having ctenoid scales on both sides like the soles, namely *Ancylosetta*, said to be very close to *Paralichthys*.*

I had reached these conclusions from the scales, when I fortunately met Professor G. H. Parker, and mentioned them to him. He at once kindly directed my attention to his paper on the optic nerves of flat-fishes, published in the Bulletin of the Museum of Comparative Zoology, Vol. XL (1903). In this work he shows that the condition of the optic chiasma in the Soleidae is as in ordinary Teleosts, whereas in the Pleuronectidae it is modified. He therefore concluded that "the Soleidae are not degraded Pleuronectidae, but degenerate descendants of primitive flat-fishes, from which the Pleuronectidae have probably been derived." The Soleid genera examined by Professor Parker were the same as mine; his Pleuronectids were *Atheresthes*, *Eopsetta*, *Hippoglossoides*, *Psettichthys*, *Paralichthys*, *Hypsopsetta*, *Parophrys*, *Isopsetta*, *Oncopterus*, *Limanda*, *Pseudopleuronectes*, *Pleuronectes*, *Liopsetta*, *Glyptocephalus*, *Lophopsetta*, *Platophrys*, *Syacium*, *Azevia*, *Citharichthys*, *Etropus*. Unfortunately, he did not see *Ancylosetta*, but it seems very unlikely that it would depart from the condition he found in all the other genera.

GADIDE AND ALLIES.

The table below separates the scales of a number of Gadoids, the specimens all from the Bureau of Fisheries Station at Woods Hole, except the Macrouridae, which are (except *Macrourus* sp.) from the U. S. National Museum.

- A. Apical field of scales with long spines (Macrouridae).
- | | |
|--|----|
| Basal circuli sharply angulate in the middle | 1. |
| Basal circuli not sharply angulate | 2. |
1. Apical teeth shorter, densely set, no circuli visible between them
Macrourus bairdii Goode and Bean.
 Lat. 39.53 N., Long. 70.9 W. (Albatross).
- Apical teeth longer, not densely set, circuli very conspicuous between them *Macrourus* sp.
 Albatross Sta. 2426.
2. Scale very broad and short; teeth very long, many projecting far beyond margin *Coryphænoides rupestris* Gunner.
 (Albatross.)
- Scale not greatly broader than long; teeth shorter, not or hardly projecting beyond margin . *Coelorhynchus caribbaeus* (Goode & Bean).

These scales must be called ctenoid, yet the margin itself is not dentate, except slightly in *Macrourus* sp. The scales of *Capros*, as figured by Goodrich, have similar teeth; *Capros* is, of course, an entirely different fish.

*Jordan & Evermann, Bull. 47, U. S. N. M., Part III, p. 2634. In this work the scales of *Paralichthys oblongus* are said to be "weakly ctenoid or cycloid." Those examined by me are strictly cycloid.

B. Scales cycloid, wholly without spines (Gadidae and Merlucciidae).

a. Scales without radii (Merlucciidae, Phycinae, Gaidropsarinae).

Scales elongate, with a strong median transverse furrow, variously developed, sometimes only near the margins, never crossing the nucleus; circuli not angled *Enchelyopus cimbrius* (L.).
Eel Pond, Woods Hole.

Scales larger, rather broad, without such a distinct median furrow, and with the basal circuli variously angled 1.

1. Region above the nucleus (except in latinucleate* scales) conspicuously finely pitted *Merluccius bilinearis* (Mitchell).
Woods Hole, Mass.

Region above the nucleus not or hardly pitted
Urophycis regius (Walb.).
Woods Hole, Mass.

b. Scales with numerous radii (Gadinae, Brosminae).

Scales very long and narrow (about 4 mm. and $1\frac{1}{2}$ broad), the central area usually free from sculpture and the fine radii broken *Brosme brosme* (Müll.)

Scales not so long and narrow, usually with a fine reticulated sculpture all over, though latinucleate scales of *Microgadus* resemble those of *Brosme* in structure though not in shape 1.

1. Scales comparatively large, about 7 to 8 mm. long and 4 to 5 broad *Melanogrammus aeglefinus* (L.).

Scales smaller, less than 5 mm. long 2.

2. Scales smallest (about 2 mm. long), narrow *Pollachius virens* (L.).
Woods Hole.

Scales medium (between 3 and 5 mm.) *Gadus callarias* L. and
Microgadus tomcod (Walb.).

The scales of the Macronridae, except for the shape (round or transversely elongate) and the spines, agree with those of the Merlucciidae and Phycinae, having more or less angled circuli and no radii. Those of the Gadinae and Brosminae are entirely different, and could not have been derived from those of the others. According to the scales, some type allied to the Macronridae may have given rise to the different lines represented by *Merluccius*, *Urophycis* and *Enchelyopus*; but the Gadinae with the Brosminae must have another origin, although no doubt all can be referred to a common ancestor by going back far enough. There is no essential difference between the Gadinae and Brosminae scales, but in my preparation of *Brosme* all the scales are latinucleate except one.

* Latinucleate scales are those in which the nuclear region is broadly modified, the normal sculpture largely suppressed or altered, and the radii more parallel. This dimorphism is of general occurrence among fish scales, and appears to be due to regeneration after loss of the original scales.

CYPRINIDÆ.

The following interesting species are described from the collection of the Bureau of Fisheries at Washington and (*Algansea* and *Lepidomeda*) the National Museum:

- (1.) *Algansea sallaei* (Günther). Scales oblong, subquadrate, nearly parallel-sided, slightly over 2 mm. long, about $1\frac{1}{3}$ wide; nucleus subbasal; radii all around; apical radii about 10 or 12, the inter-radial circuli very widely spaced. This is one of the few American Cyprinids having basal radii; the scales are not unlike those of *Temeculina*. The fish is from Guanajuato, Mexico (A. Dugès).
- (2.) *Mylocheilus caurinus* (Richardson). Snake River, Idaho (Evermann). Large scales, about $5\frac{1}{3}$ mm. long and 5 broad; nucleus subbasal; no basal radii; apical radii about 25 or more; apical circuli widely spaced, not at all angulate in middle; very obtuse laterobasal angles. Except for the non-angulate apical circuli, this reminds one of *Semotilus*.
- (3.) *Richardsonius siuslawi* (Evermann & Meek). Siuslaw River, Oregon (S. E. Meek). Scales quite normal for the typical subgenus *Richardsonius*; apical radii about 18, some imperfect.
- (4.) *Exoglossum maxillingua* (Le Sueur). Roanoke, Va. Scales about $2\frac{1}{2}$ to $2\frac{3}{4}$ mm. long and broad; nucleus subbasal; no basal radii; apical radii about 20; apical circuli widely spaced, not angled; laterobasal angles evident but obtuse. The structure is almost as in *Mylocheilus*.
- (5.) *Lepidomeda vittata* Cope. Colorado Chiquito River. *Transversely* oval scales, with the usual subbasal nucleus; apical radii about 7, strong; no basal radii; apical circuli extremely widely spaced. These scales are quite different from those of *Gila*, a fact useful for the separation of the fishes from juvenile *Gila*, occurring in the same region.